

# Identifying Chemical Compounds from Wastewater Discharges

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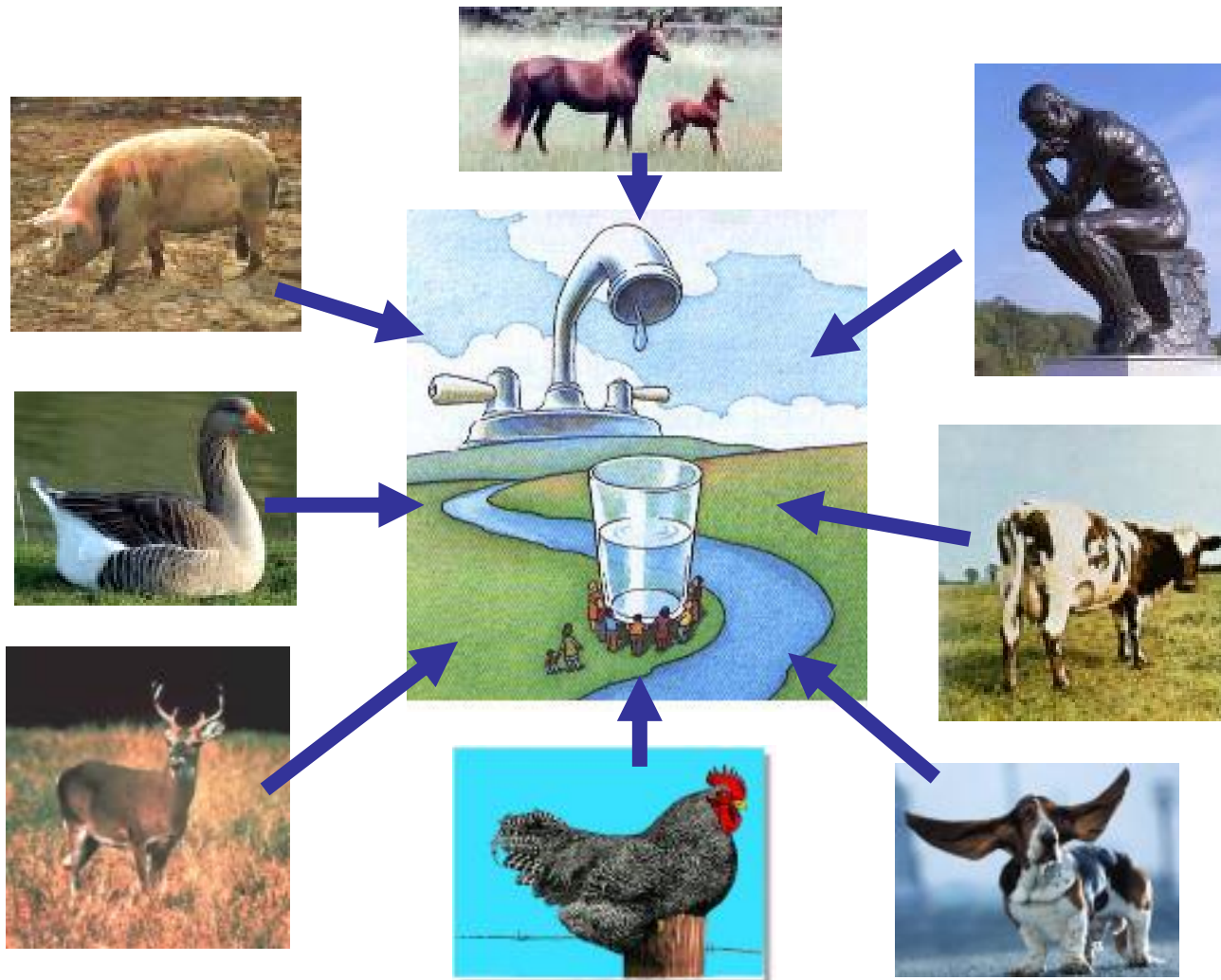
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*Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.*

# Sources of Fecal Pollution



# Why use Chemical Indicators?

- Rapid analysis times
- Able to discriminate human from animal fecal material
- Suite of compounds with various physical/ chemical properties may be more impervious to hydrological diversity
- However, must make sure they are persistent enough to survive wastewater treatment, but not so recalcitrant that they become ubiquitous
- “Transport of Chemical and Microbial Compounds from Known Wastewater Discharges: Potential for Use as Indicators of Human Fecal Contamination”  
*ES&T* **2005**, 39, 5157-5169

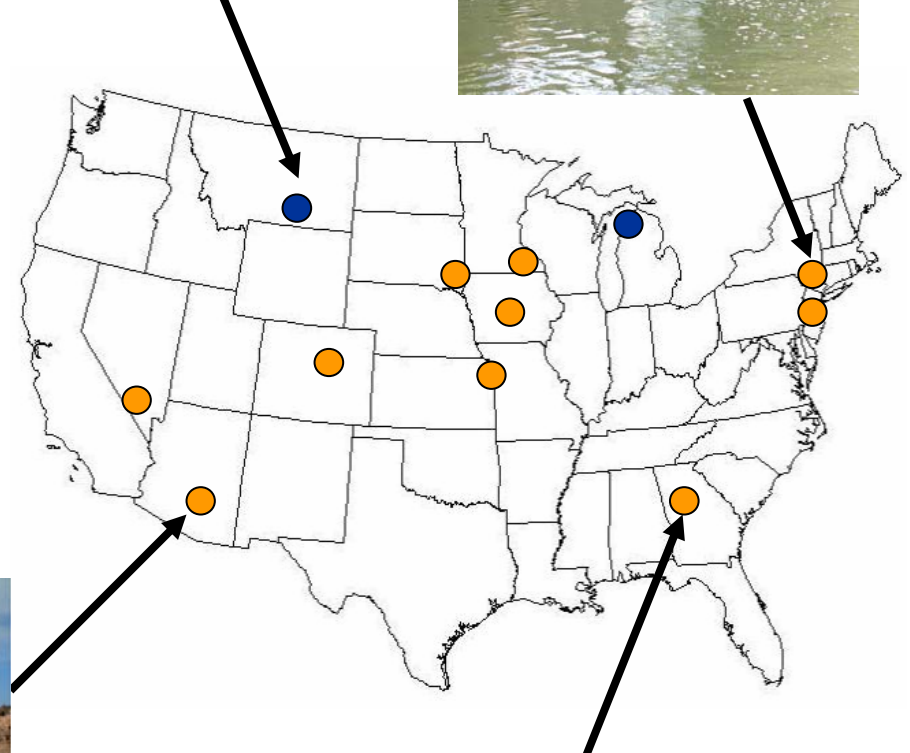


# Sampling Locations - 2002

- Focus on wastewater treatment plants

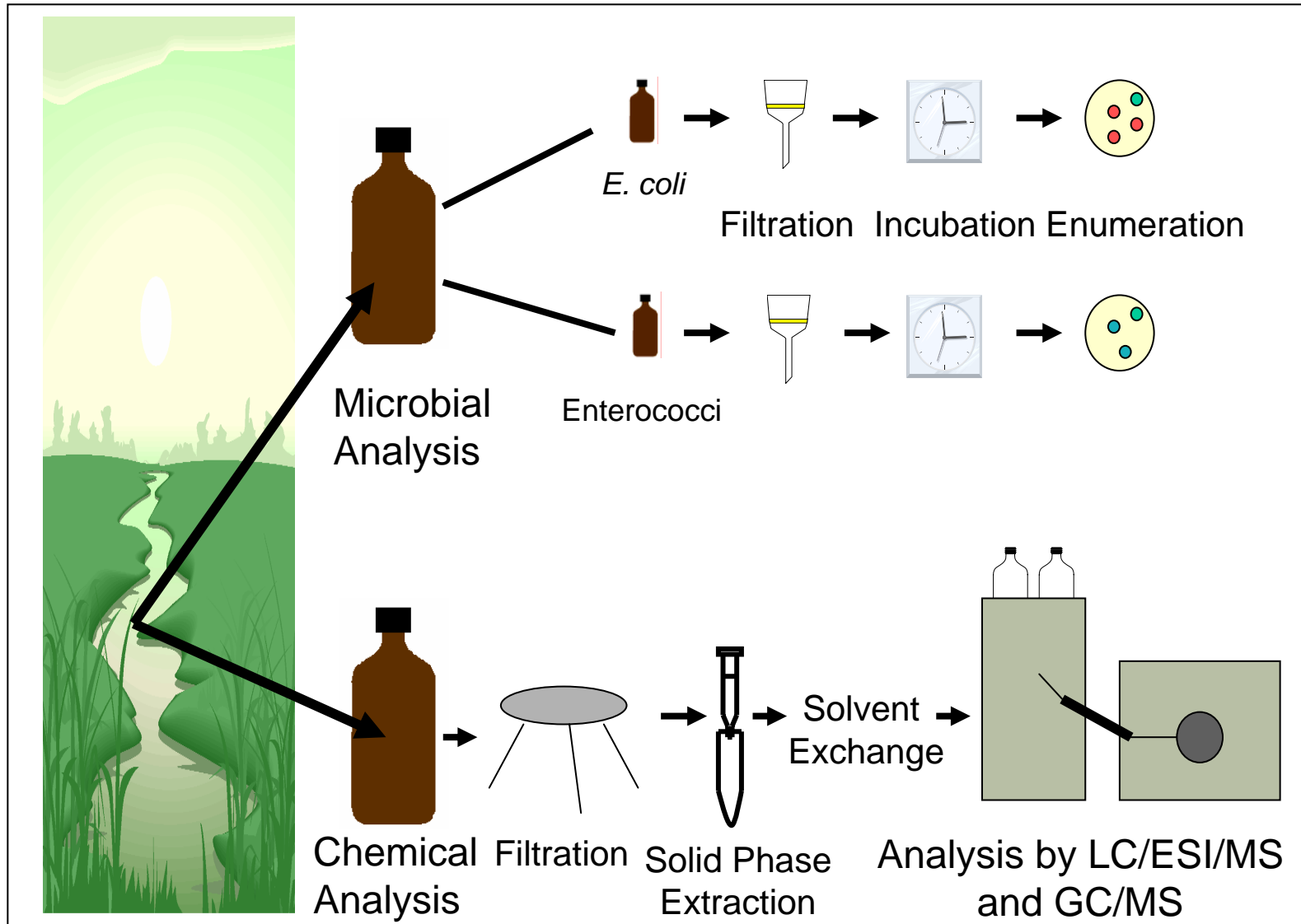
- One Upstream
- One Effluent
- Two Downstream

- Two Background Locations





# Experimental Approach

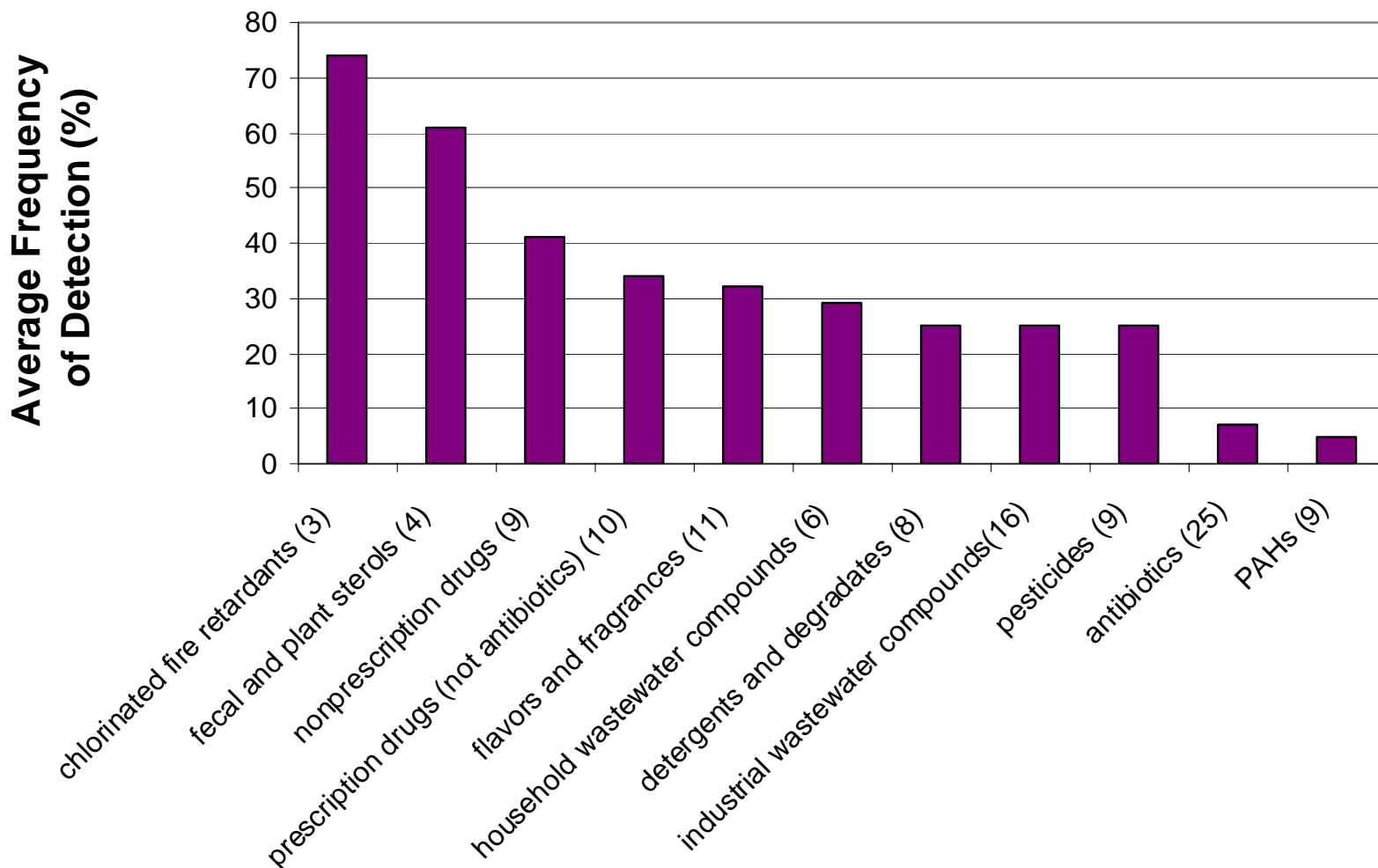


# Overview of Results

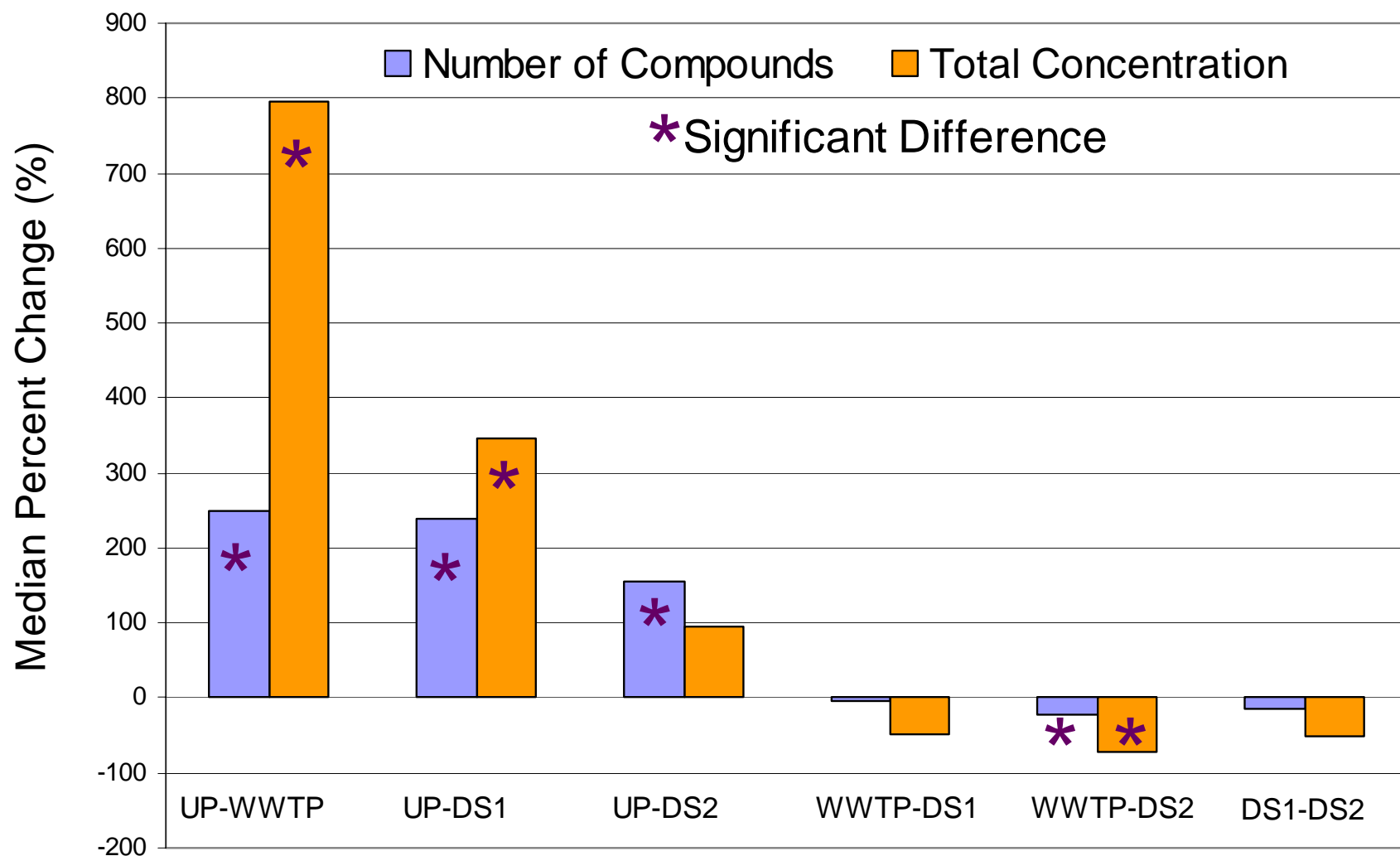
- Bacteria concentrations tended to be lower in the WWTP effluent samples, due to disinfection processes.
- Both bacteria detected at both of the reference locations. Enterococci at Montana (373 cfu/ 100 mL) exceeded guidelines.
- 78 out of 110 chemicals were found in at least one sample.
- 6 chemicals were found in at least 75 % of the samples.
- Median numbers of detections by sample type: Upstream, 10; WWTP effluent, 35; 1st Downstream, 32; 2nd Downstream, 24.
- At the reference locations, 3 chemicals with a total concentration of 0.0326 µg were found in Michigan; no detects in Montana.



# Frequency of Detection by Use Classification



# Instream Variability





# 35 Most Frequently Detected Compounds

Fecal Sterols   Pharmaceuticals   Misc.   Wastewater   Detergents and Fragrances

cotinine

sitosterol

4-nonylphenol  
monoethoxylate

5-methyl-1H-  
benzotriazole

cholesterol

sulfamethoxazole

triclosan

phenol

carbamazepine

caffeine

coprostanol

triphenylphosphate

tonalide (AHTN)

ethanol,2-butoxy-  
phosphate

trimethoprim

1,7-dimethylxanthine

tri(dichlorisopropyl)  
phosphate

N,N-diethyltoluamide  
(DEET)

dehydronifedipine

pentachlorophenol

tri(2-chloroethyl)  
phosphate

tributylphosphate

galaxolide (HHCB)

4-octylphenol  
diethoxylate

3,4-dichlorophenyl  
isocyanate

benzophenone

diphenhydramine

bisphenol-A

codeine

diltiazem

acetaminophen

1,4-dichlorobenzene

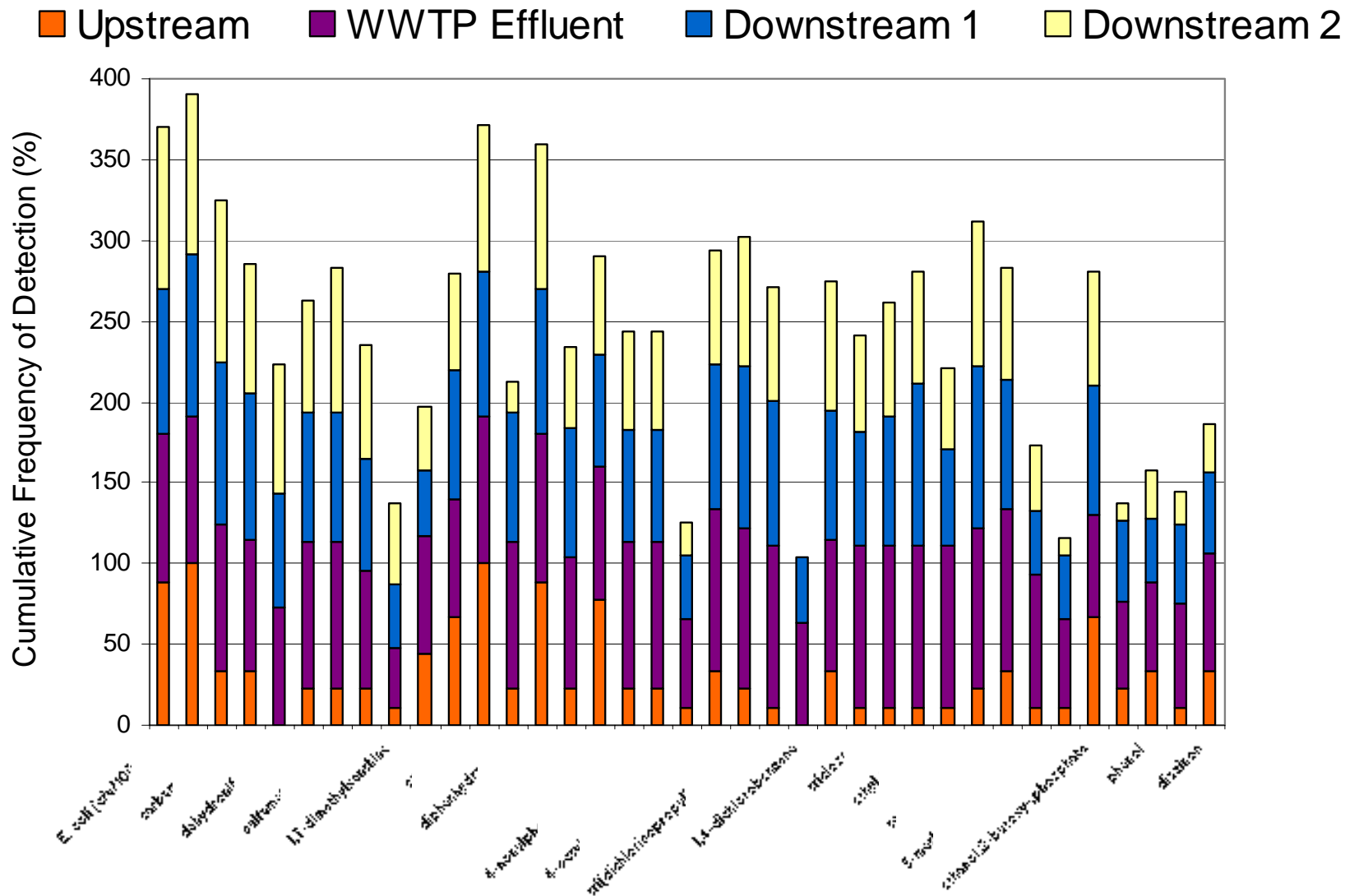
ethyl citrate

4-nonylphenol  
diethoxylate

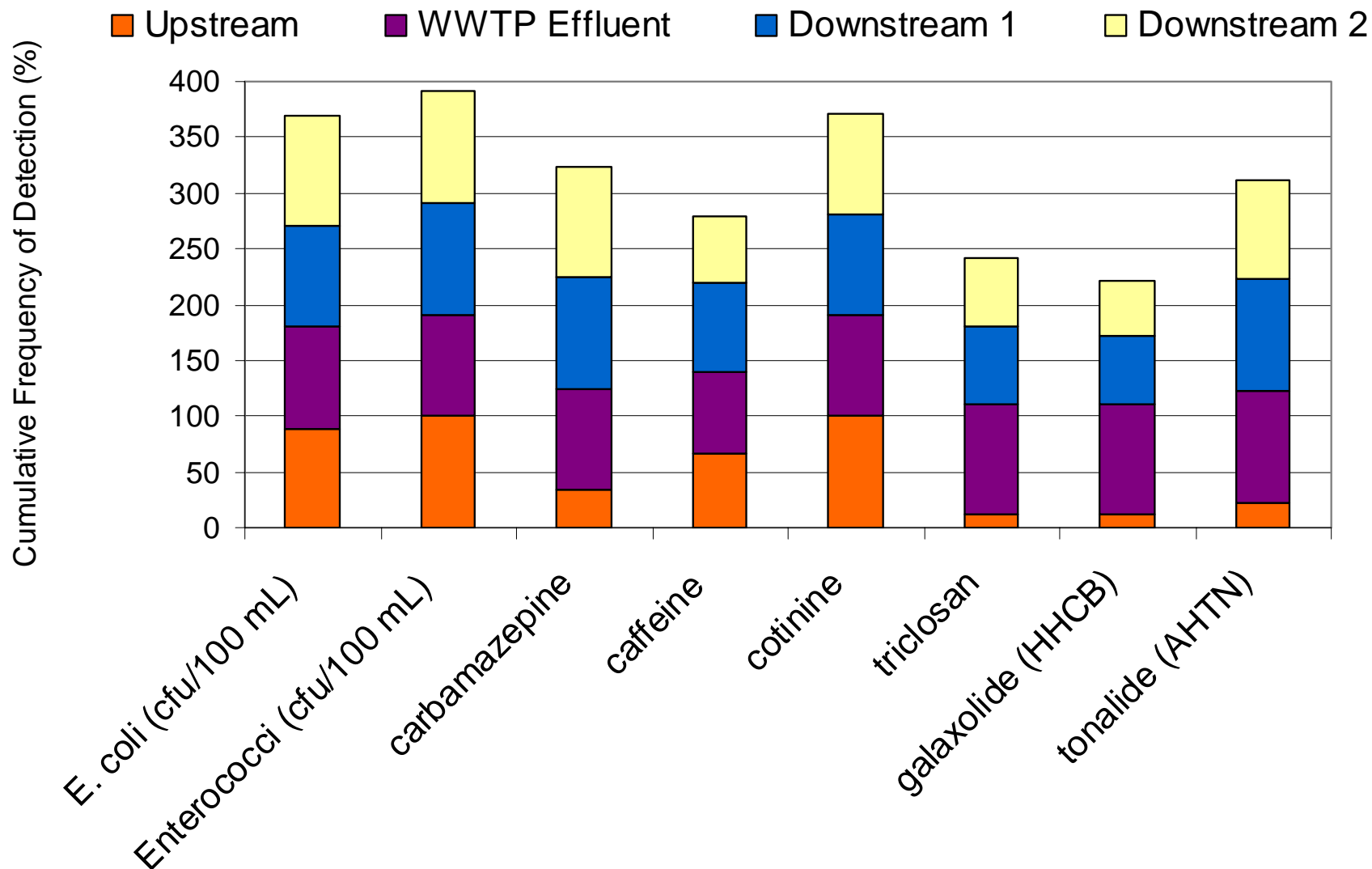
diazinon



## Frequency of Detection by Sample Site



# Frequency of Detection by Sample Site



# Significant Differences in Concentration Between Sample Sites

None   **UP-WWTP only**   **UP-WWTP and WWTP-DS2**  
**WWTP-DS2 only**   **UP-WWTP, WWTP-DS1 and WWTP-DS2**

1,7-dimethylxanthine	1,4-dichlorobenzene	3,4-dichlorophenyl isocyanate	diltiazem	4-octylphenol diethoxylate
acetaminophen	carbamazepine	4-nonylphenol diethoxylate	diphenhydramine	diazinon
caffeine	codeine	4-nonylphenol monoethoxylate	tri(2-chloroethyl) phosphate	pentachlorophenol
cotinine	dehydronifedipine	5-methyl-1H-benzotriazole	tri(dichlorisopropyl) phosphate	sitosterol
ethanol,2-butoxy-phosphate	N,N-diethyltoluamide (DEET)	benzophenone	triclosan	ethyl citrate
phenol	sulfamethoxazole	bisphenol-A	triphenylphosphate	galaxolide (HHCB)
	tributylphosphate	cholesterol		tonalide (AHTN)
	trimethoprim	coprostanol		



# Preliminary Results

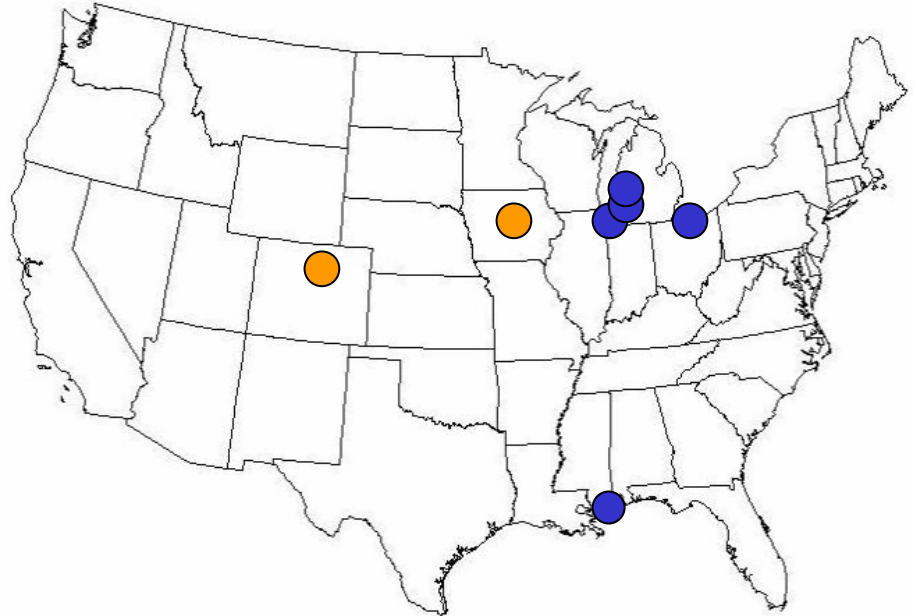
- Pharmaceuticals and other chemicals survive wastewater treatment.
- Upstream “background” levels of many of the pharmaceuticals and wastewater compounds are low (especially when compared to the indicator bacteria), and indicate that they are not too ubiquitous.
- The downstream samples decrease at different rates for the chemicals.
- Pharmaceuticals and other wastewater compounds may be able to be utilized as chemical indicators of human fecal contamination. Factors such as environmental persistence must be considered when preparing compound list.





# Current Work

- Lagrangian Studies
- Epidemiology Studies



# Acknowledgements

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